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(54) **Water-jet operating head for cutting materials with a hydro-abrasive high pressure jet**
Wasserstrahlkopf zum Schneiden von Material mit hydro-abrasivem Hochdruckstrahl
Tête à jet d'eau pour le coupage d'un matériau par jet d'eau hydro-abrasif à haute pression

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Description

[0001] The present invention relates to water-jet operating heads using a high pressure hydro-abrasive jet, for cutting various materials, such as glass, stone, marble, metals, plastic materials, ceramic materials or in general any other material suitable to be worked by the above mentioned technology.

[0002] Operating heads of the above indicated type are to be used on machines in which the operating head is movable along one or more axes by means of electronically controlled motor means in order to perform cutting operations on pieces preliminarily arranged on the machine table. In machines of this type the addition of the abrasive agent to the high pressure water jet enables cutting operations to be performed also on materials of medium and high hardness, and in general on all those materials for which cutting by a pure water jet is not possible.

[0003] The invention relates in particular to a water-jet operating head of the known type including:

- a head main portion, intended to be mounted on an operating machine, and defining an axial passage for feeding a high pressure water flow,
- a nozzle carrying support which is removably connected to the head main portion,
- a jet focusing nozzle, for emitting a high pressure hydro-abrasive jet, mounted on said nozzle-carrying support and defining an ejection passage which is arranged downstream of said feeding passage and is in communication therewith,
- a primary nozzle carried by said nozzle-carrying support upstream of the focusing nozzle and having a body with an orifice of predetermined diameter interposed in the communication between the water flow feeding passage and the hydro-abrasive jet ejecting passage, and
- at least one connecting element carried by said head, through which an abrasive agent can be fed into the high pressure water flow at a mixing chamber defined within the nozzle-carrying support, between the primary nozzle and the focusing nozzle.

[0004] Machines provided with operating heads of the above indicated type have been produced and marketed for some time by the same Applicant.

[0005] A problem which is encountered in the operating heads of the above described type lies in the wear of the components inside the head through which the high pressure jet flows, as well as in the wear of some parts in which also the added abrasive flows. This causes an enlargement of those passages, with a resulting decrease of effectiveness and precision in the cutting operation. The parts which are more subject to wear are the above mentioned focusing nozzle and the primary nozzle. The focusing nozzle has the function of focusing a coherent jet of water and abrasive which is projected against the

piece surface to cut the material being worked. The primary nozzle, along with its orifice of predetermined reduced diameter, has the function of accelerating the water jet and is arranged and self-centered inside the nozzle-carrying support. Between the primary nozzle and the focusing nozzle there is interposed a mixing chamber where the water jet is added with abrasive sand. The primary nozzle, the nozzle-carrying support along with the mixing chamber and the focusing nozzle are partly or completely preassembled with each other.

[0006] During use of the machine, it is necessary to periodically replace the above mentioned parts of the head which are subject to wear in order to always ensure the requested effectiveness and precision of the cutting operations.

[0007] A water-jet head of the type indicated in the preamble of claim 1 is known from US-A-5 794 858. In this known solution, the operations for replacing the parts subject to wear and particularly the nozzle, are time-consuming, cumbersome and not adapted to be automated.

[0008] The object of the present invention is that of providing a water-jet operating head of the above indicated type in which those parts which are subject to wear can be replaced with simple and quick operations, preferably also in an automated manner, so as to reduce to a minimum the time requested for the replacement operation, increasing thereby the productivity of the machine.

[0009] A further object of the invention lies in the provision of an operating water-jet head which achieves the above indicated purpose with a simple and relatively inexpensive structure.

[0010] In view of achieving these objects, the present invention provides a water-jet operating head having the features indicated in the annexed claim 1.

[0011] Due to the above mentioned features, the operation for replacing the nozzle-carrying support, along with the mixing chamber, the primary nozzle and the focusing nozzle associated thereto can be carried out simply and rapidly and if necessary also in an automated manner (which is not possible instead in the known solution of US-A-4 555 872, due to the threaded couplings between the components of the head).

[0012] Preferably, the above mentioned connecting element is carried by said main support and is in communication with an auxiliary passage defined by two substantially radial holes, aligned with each other, which are respectively formed in said main support and in said nozzle-carrying support. The main support and the nozzle-carrying support are further provided with mutual engagement means cooperating with each other for defining the proper coupling position in which said holes are aligned with each other.

[0013] In a preferred embodiment, the cylindrical body of the nozzle-carrying support has a conical centering end for facilitating insertion of the nozzle-carrying support within said cylindrical cavity of the main support.

[0014] The head can be provided with two connecting

elements, for feeding abrasive material, which are diametrically opposite to each other.

[0015] Further features and advantages of the invention will become apparent from the following description with reference to the annexed drawings, given purely by way of non limiting example, in which:

figure 1 is a diagrammatic perspective view of a machine for performing cutting operations with the water-jet technology,

figure 2 is an elevational view of a water-jet operating head according to the known art,

figure 3 is a view partially in cross-section, taken along line III-III in figure 2, of the known operating head,

figure 4 is a view partially in cross-section of a first embodiment of the water-jet head according to the present invention, and

figure 5 is a view in cross-section of a second embodiment of the water-jet head according to the present invention.

[0016] With reference to figure 1, numeral 1 generally designates a machine for cutting operations with a hydro-abrasive jet. Machine 1 comprises a fixed bench 2 defining a support board 3 for the pieces to be worked. A cross-member 4 is arranged above board 3 and has its ends slidably mounted along the two flanks of bench 2 along a direction X. Reference numeral 5 designates a carriage slidably mounted on cross-member 4 along the longitudinal direction Y of the cross-member. A slide 6 carrying a water-jet operating head which is generally designated by reference numeral 7 is slidably supported along a vertical axis Z by carriage 5. The movements of head 7 along the three axes X, Y, Z are driven by respective electric motors (not shown) controlled by the electronic unit E of the machine.

[0017] By way of example, figure 1 shows the case of a head 7 with five axes, that is of the type in which head 7 can be moved, not only along the above mentioned three axes X, Y, Z, but also around two further rotational axes, in order to incline the head nozzle according to an angle which can be varied with respect to the vertical direction, with the further possibility of rotating the nozzle inclined thereby around the vertical axis. The details relating to the drive of the two above mentioned further axes of the machine are not provided herein, since they can be made in any known way and also because this aspect, taken alone, does not fall within the scope of the present invention, and it is clearly evident that the operating head according to the invention is applicable both to the case of three axis heads as well as to the case of five axis heads.

[0018] The machine illustrated in figure 1 is described herein only by way of example. Indeed the machine may have any different configuration, with a different type of piece-carrying board, also including the case of a movable board, and with a different orientation of cross-mem-

ber 4.

[0019] Figures 2, 3 show a typical example of a water jet head according to the prior art. With reference to these figures, the head, generally designated by reference numeral 7, comprises a main portion 7A which is to be carried by the structure of slide 6 (see figure 1) of the machine. The main portion 7A comprises a tubular body defining an axial passage 8 for feeding a high pressure water flow coming from a conduit (not shown) connected to passage 8 by a connecting element 7C.

[0020] The main portion 7A of the head ends with a lower end with an outer thread, on which a tubular support 9 is screwed carrying the focusing nozzle 10 of the head, having the function of focusing a coherent jet of water and abrasive which is projected against the piece surface in order to perform cutting of the material to be worked. To this end, the nozzle-carrying support 9 has an upper mouth with an inner thread screwed until the lower end of the main portion 7A and has an inner cylindrical cavity 11, of reduced diameter, within which there is received the body of the focusing nozzle 10. The focusing nozzle 10 has an axial passage 12 for ejecting the hydro-abrasive jet.

[0021] Between the lower end surface of the tubular body 7A and the mouth of the cavity 11 of reduced diameter there is interposed a primary nozzle 13, such as in form of a ring, of hard material, having a central orifice 14 with a reduced predetermined diameter, which is for causing an acceleration of the water flow coming from passage 8. The cylindrical cavity 11 defines a mixing chamber C between the primary nozzle 13 and the focusing nozzle 10, for mixing the abrasive material with the water jet. Into chamber C merges a substantially radial hole 15 formed in the tubular support 9, for adding an abrasive agent (such as garnet) to the water jet coming from passage 8. Hole 15 has an enlarged mouth which receives a connecting element 16 to which a tube 17 is connected (shown only partially in figure 3) for supplying the abrasive agent. As indicated, it is possible to provide for two connecting elements, arranged diametrically opposite to each other.

[0022] The annexed drawings do not show the means for supplying water under pressure and abrasive agent to the head, these means being of any known type.

[0023] The body of the focusing nozzle 10 is locked within the nozzle-carrying support 9 by a bush 18 screwed onto a threaded end portion 19 of support 9.

[0024] As already clarified in the foregoing description, during use of water jet heads of the type shown in figures 2, 3 it becomes necessary to periodically replace the parts subject to wear, specifically the focusing nozzle 10, the primary nozzle 13 and support 9 defining the mixing chamber C, in order to avoid a loss of efficiency and precision in the cutting operations.

[0025] In order to enable replacement, the entire structure constituted by support 9 with the primary nozzle 13 and the focusing nozzle 10 is dismantled by unscrewing support 9 from the lower end portion of the main portion

7A of the head after which a new structure of the same type can be screwed in place. These operations are performed manually by an operator, engaging an engagement part 7B of the main portion 7A with the aid of a wrench, in order to hold it against rotation, and rotating support 9 with the aid of another wrench, which engages an engagement portion 9B provided on the outer surface of support 9. This operation is relatively cumbersome and time-consuming and further requires, in order to be carried out, that tube 17 for adding the abrasive agent is preliminarily detached from the connecting element 16, which remains associated to support 9 when the latter is removed, to be replaced.

[0026] A first embodiment of the invention is shown in figure 4 of the annexed drawings and can be used both in a three axis head and in a five axis head. In this figure, parts which are common to those of figures 2, 3 are designated by the same reference numerals. A first difference with respect to the case of figures 2, 3 lies in that the connecting element 16 is rigidly connected to the main portion 7A of the head. This of course applies to each connecting element in case there are provided two connecting elements which are diametrically opposite to each other.

[0027] In the illustrated example, the main portion 7A has a first element 71, defining the axial passage 8, and a second element 72, of tubular configuration, whose upper end is rigidly connected by an interference fit to the lower end portion of element 71. This arrangement is chosen only for simplifying the construction, while it is clearly understood that, in principle, the two elements 71, 72 could be made in a single piece and together define the main portion 7A of the head, which is not removed when the worn parts are replaced.

[0028] The tubular element 72 of the main portion 7A of the head defines a main support, having a cylindrical cavity 20 within which the tubular body of the support 9, carrying the focusing nozzle 10, is adapted to be slidably and removably received,. Also in this case, the body of the focusing nozzle 10 defining the passage 12 for ejecting the hydro-abrasive jet is received within the tubular body of support 9. Also in this case, between the lower end surface of the main support 71 and the upper end surface of the focusing nozzle 10 there is interposed the primary nozzle 13 of hard material, with orifice 14 having a predetermined reduced diameter. Furthermore, in the illustrated case, between the primary nozzle 13 and the body of focusing nozzle 10 there is interposed a further primary nozzle 13a having an axial orifice 14a of reduced diameter, for providing the reduced cross-section for the jet acceleration.

[0029] As already indicated above, in the case of the invention the connecting element 16 is carried by the main portion 7A of the head and in particular, in the case of the illustrated example, the connecting element 16 is carried by the main support 72 forming part of the main portion 7A. The connecting element 16 is received within a substantially radial hole 21 formed in the tubular ele-

ment 72 and aligned with a substantially radial hole 22 formed in the tubular body of support 9 as well as with a substantially radial hole 23 formed in the primary nozzle 13a. In this manner, the aligned holes 21,22,23 define an auxiliary passage merging into orifice 14a of the primary nozzle 13a, through which the abrasive agent can be added to the high pressure water jet, upstream of passage 12 of the focusing nozzle 10. As already indicated, two connecting elements may be provided, which are diametrically opposite to each other, in which case the above described arrangement of the passages is made for each connecting element.

[0030] Support 9 carrying the focusing nozzle 10 and element 72 forming part of the main portion 7A of the head have mutually engagement means cooperating with each other for defining the proper coupling position, in which the holes 21, 22 are aligned with each other. In the case of the illustrated example, these mutual engagement means comprises two radial grains 24, diametrically opposite to each other, carried by support 9 and projecting radially therefrom. Grains 24 are received within corresponding front slots 25 formed on the lower front surface of the tubular element 72.

[0031] Furthermore, preferably the primary nozzle 13 and support 9 have mutually engaging surfaces formed so as to define the proper coupling position in which hole 23 is aligned with hole 22.

[0032] Support 9 carrying the focusing nozzle 10 is axially held within the cylindrical cavity 20 of element 72 forming part of the main portion 7A of the head by a rotatable nut ring 26 carried by support 9 and screwed onto a lower threaded portion 27 of the tubular element 72 in order to hold support 9 axially in position, by reacting against an annular shoulder 28 formed on the outer surface of support 9.

[0033] In replacement of nut ring 26 any other type of known device could be used, which is adapted to hold the support 9 within cavity 20, while being movable between an operative condition and an inoperative condition. In case it is desired to carry out the nozzle replacement operation in an automatic manner, for example any known coupling device of the type conventionally used in machine tools to enable automatic tool change could be used.

[0034] In use of the head of figure 4, the high pressure water jet reaches the ejecting passage 12 of the focusing nozzle 10 after passing through passage 8 formed in the main portion 7A of the head, through orifice 14 of the primary nozzle 13 and orifice 14a of the primary nozzle 13a. The abrasive agent coming from tube 17 is added to the water jet by making it to flow through the connecting element 16 and the aligned holes 21, 22, 23. When wear of the wall of the nozzles 13, 13a and passage 12 of the focusing nozzle 10 becomes excessive, these parts can be replaced with simple and quick operations, since it is simply sufficient to unscrew the nut ring 26 and remove support 9, with the focusing nozzle 10 and the nozzles 13, 13a carried thereby, with no need of removing tube

17 for the abrasive agent, since the connecting element 16 remains associated to element 72 forming part of the main portion 7A of the head, which has not to be removed. Mounting of a new nozzle only requires the provision of an identical component and insertion of support 9 forming part of this component within cavity 20 of element 72, with subsequent locking by screwing the respective nut ring 26. Naturally, the seal 30 which surround the body of the focusing nozzle 10 and which is carried by support 9 remains always associated to support 9 and the focusing nozzle 10.

[0035] Figure 5 shows a second embodiment of the invention which, by way of example, is referred to the case of a five axis head. However, the construction of the head is absolutely identical to that of figure 4 (for which reason parts corresponding to those of figure 4 have been designated by the same reference numerals).

[0036] The only relevant difference with respect to the case of figure 4 lies in that in this case the cylindrical body of support 9 carrying the focusing nozzle 10 ends with the conical portion 9a which is received within a corresponding conical portion 20A of the cylindrical cavity 20 within which support 9 is slidably mounted. The function of conical portion 9A is that of favouring centering within cavity 20 at the time of insertion of support 9 within the element 72 of the main portion 7A of the head. For the rest, the head of figure 5 differs from that of figure 4 only for the configuration of its various elements, which however, are conceptually similar to those of figure 4. It is to be stressed in any case that both figure 4 and figure 5 relate to exemplary embodiments which are provided herein with no limiting intention. For example, also in the solution of figure 4 the cylindrical body 9 might be made with a conical end for favouring the centering within cavity 20.

[0037] In the case of figure 5, finally, the locking ring 26 is coupled with element 72 of the main portion 7A of the head by means of a quick-locking thread-like coupling, with one edge 26a of the head projecting radially inwardly into engagement on inclined ribs 72a formed on the outer cylindrical surface of element 72. Moreover, ring 26 is provided with front engagement portions 26b, to be engaged by an operating tool. In this manner, the locking ring can be brought from the released position to the operative locking position by being rotated through an angle lower than 360°.

[0038] In general, the locking ring 26 can be constituted by any type of quick locking ring, for example also of a bayonet-like type.

[0039] As also indicated, any other type of quick-locking element, as those used for automatic tool change in machine tools and robots, could also be used.

[0040] As it is clearly apparent from the foregoing description, the water jet head according to the present invention has a relatively simple structure, constituted by reduced number of parts, but yet ensures a substantially improvement with respect to the heads of known type with regard to simplicity and rapidity of operations which

are necessary for replacing the nozzle.

[0041] In an electronically controlled machine of the type shown in figure 1, the head according to the invention enables the replacement of the worn part of the head to be performed also automatically. To this end, machine 1 includes a magazine area M (see figure 1) having one or more empty seats and one or more seats occupied by spare parts, each spare part comprising a nozzle-carrying element 9 with the associated elements 10 and 13 which are subject to wear. The control unit E is programmed for performing an automatic change of the part including the worn elements carried by head 7 by moving head 7 in proximity of an empty seat of magazine M. The locking element 26 of support 9 is brought to its inoperative condition, whereby support 9 (with the focusing nozzle 10 and nozzles 13, 13a) is deposited into the empty seat of the magazine. At this time the head is moved over another seat of the magazine which is occupied by a spare part, and is then lowered thereon so as to couple element 72 of the head with support 9 of the spare part. When coupling has been carried out, the locking element 26 is moved to its operative position and the head is brought back to the work position, with the new nozzle mounted thereon.

[0042] The scope of the invention is defined by the appended claims.

Claims

1. A water-jet operating head for cutting materials with a hydro-abrasive high pressure jet, including:

- a head main portion (7A), intended to be mounted on an operating machine, and defining an axial passage (8) for feeding a high pressure water flow,
- a nozzle-carrying support (9) which is removably connected to the head main portion (7A),
- a jet focusing nozzle (10) for emitting a high pressure hydro-abrasive jet, mounted within said nozzle-carrying support (9) and defining an ejection passage (12) which is arranged downstream of said feeding passage (8) and is in communication therewith,
- a primary nozzle (13, 13a) carried by said nozzle-carrying support (9) upstream of the focusing nozzle (10) and having a body with an orifice (14, 14a) of predetermined diameter interposed in the communication between the water flow feeding passage (8) and the hydro-abrasive jet ejecting passage (12), and
- at least one connecting element (16) carried by said head (7), through which an abrasive agent can be fed into the high pressure water flow at a mixing chamber (C) defined within the nozzle-carrying support (9), between the primary nozzle (13, 13a) and the focusing nozzle (10),

wherein:

- said connecting element (16) is carried by said head main portion (7A) and therefore remains associated therewith when the aforesaid nozzle-carrying support (9) is removed from said main portion,
- said head main portion (7A) comprises a main support (72) defining a cylindrical cavity (20) and said nozzle-carrying support (9) comprises a body adapted to be slidably and removably received within said cylindrical cavity (20) of said main support (72), and
- said head (7) further comprises a locking element (26) for axially locking the nozzle-carrying support (9) in its coupling position within said main support (72), said locking element being switchable between an operative condition and an inoperative condition,

said head (7) being **characterized in that** said locking element (26) is a separate element with respect to the nozzle-carrying support (9).

2. Operating head according to claim 1, **characterized in that** said primary nozzle (13, 13a) is in form of a ring and is carried by said nozzle-carrying support (9) so as to remain associated to the latter when the nozzle-carrying support (9) is removed from the main support (72) of the head (7).
3. Operating head according to claim 1, **characterized in that** said primary nozzle (13, 13a) is in one piece with said nozzle-carrying support (9).
4. Operating head according to claim 1, **characterized in that** the body of the nozzle-carrying support (9) has a centering conical end (9A) facilitating insertion of the nozzle-carrying support (9) within said cylindrical cavity (20) of the main support (72).
5. Operating head according to claim 1, **characterized in that** said connecting element (16) is carried by said main tubular support (72) and is in communication with an auxiliary passage defined by two substantially radial and aligned holes (21, 22) which are respectively formed in said main support (72) and in said nozzle-carrying support (9), and **in that** said main support (72) and said nozzle-carrying support (9) are provided with mutually engaging means (24, 25) which cooperate with each other to define the correct position in which said cooperating holes (21, 22) are aligned with each other.
6. Operating head according to claim 1, **characterized in that** two connecting elements (16) are provided, diametrically opposite to each other.

7. Operating head according to claim 1, **characterized in that** said locking element is constituted by a quick-locking element.

8. Operating head according to claim 7, **characterized in that** said locking element is constituted by a locking ring (26) carried by the nozzle-carrying support (9) and rotatable by an angle lower than 360° in order to be moved from an inoperative position to an operative position in which it engages on the main support (72) for axially locking the nozzle-carrying support (9) in its coupling position within the main support (72).

9. Machine for cutting materials by means of a high pressure hydro-abrasive jet, comprising at least one water-jet operating head movable along one or more axes (X, Y, Z), **characterized in that** said head is made in accordance to one or more of the preceding claims.

10. Machine according to claim 9, **characterized in that** it comprises an electronic control unit for controlling the movement of the head (7) and a magazine (M) having one or more empty seats and one or more seats occupied by spare parts, each spare part comprising a nozzle-carrying element (9) with the associated elements which are subject to wear, said control unit being programmed to perform an automatic replacement of said part of the head (7) by the steps of:

- moving the head (7) in the proximity of an empty seat of said magazine (M),
- bringing said locking element (26) to its inoperative position, so as to deposit said part of the head into said empty seat of the magazine,
- picking-up a spare part from another seat of the magazine by engaging the respective nozzle-carrying nozzle (9) and bringing said locking element to its operative position, so as to retain the nozzle-carrying support (9) of the new spare part within the head main support (72).

Patentansprüche

1. Wasserstrahl-Funktionskopf zum Schneiden von Materialien mit einem hydroabrasivem Hochdruckstrahl, umfassend:

- einen Kopfhauptabschnitt (7A), der dazu bestimmt ist, an einer Maschine angebracht zu werden und einen axialen Leitungsweg (8) für die Zuführung eines Hochdruck-Wasserstroms bildet,
- eine Düsenträgerhalterung (9), die lösbar mit dem Kopfhauptabschnitt (7A) verbunden ist,

- eine Strahlbündelungsdüse (10) zum Emittieren eines hydro-abrasiven Hochdruckstrahls, die in der Düsenträgerhalterung (9) angebracht ist und einen Ausstoßleitungsweg (12) bildet, der stromabwärts des Zuführleitungswegs (8) angeordnet ist und mit diesem in Verbindung steht,

- eine primäre Düse (13, 13a), die von der Düsenträgerhalterung (9) stromaufwärts der Bündelungsdüse (10) gehalten ist und einen Körper mit einer Öffnung (14, 14a) eines vorbestimmten Durchmessers hat, die in der Verbindung zwischen dem Wasserstrom-Zuführleitungsweg (8) und dem Ausstoßleitungsweg (12) für einen hydro-abrasiven Strahl angeordnet ist, und

- wenigstens ein Verbindungselement (16), das von dem Kopf (7) gehalten ist und durch das ein abrasives Mittel in den Hochdruck-Wasserstrom in einer Mischkammer (C) zugeführt werden kann, die in der Düsenträgerhalterung (9) zwischen der primären Düse (13, 13a) und der Bündelungsdüse (10) ausgebildet ist,

wobei:

- das Verbindungselement (16) von dem Kopfhauptabschnitt (7A) gehalten ist und somit mit diesem assoziiert bleibt, wenn die zuvor erwähnte Düsenträgerhalterung (9) aus den Hauptabschnitt entfernt wird,

- der Kopfhauptabschnitt (7A) eine Haupthalterung (72) umfasst, die einen zylindrischen Hohlraum (20) bildet, und die Düsenträgerhalterung (9) einen Körper umfasst, der dazu eingerichtet ist, gleitfähig und lösbar in dem zylindrischen Hohlraum (20) der Haupthalterung (72) aufgenommen zu werden, und

- der Kopf (7) weiterhin ein Arretierelement (26) zum axialen Arretieren der Düsenträgerhalterung (9) in ihrer Kopplungsposition innerhalb der Haupthalterung (72) umfasst, wobei das Arretierelement zwischen einem Betriebszustand und einem außer Betrieb befindlichen Zustand umschaltbar ist,

- wobei der Kopf (7) **dadurch gekennzeichnet ist, dass** das Arretierelement (26) ein von der Düsenträgerhalterung (9) getrenntes Element ist.

2. Funktionskopf nach Anspruch 1, **dadurch gekennzeichnet, dass** die primäre Düse (13, 13a) die Gestalt eines Ringes hat und von der Düsenträgerhalterung (9) derart gehalten ist, dass sie mit letztgenannter assoziiert bleibt, wenn die Düsenträgerhalterung (9) aus der Haupthalterung (72) des Kopfes (7) gelöst wird.

3. Funktionskopf nach Anspruch 1, **dadurch gekenn-**

zeichnet, dass die primäre Düse (13, 13a) ein Stück mit der Düsenträgerhalterung (9) ist.

4. Funktionskopf nach Anspruch 1, **dadurch gekennzeichnet, dass** der Körper der Düsenträgerhalterung (9) ein zentrierendes konisches Ende (9A) hat, das das Einfügen der Düsenträgerhalterung (9) in den zylindrischen Hohlraum (20) der Haupthalterung (72) erleichtert.

5. Funktionskopf nach Anspruch 1, **dadurch gekennzeichnet, dass** das Verbindungselement (16) von der röhrenförmigen Haupthalterung (72) gehalten ist und mit einem Zusatzleitungsweg in Verbindung steht, der durch zwei im wesentlichen radiale und ausgerichtete Löcher (21, 22) gebildet ist, die jeweils an der Haupthalterung (72) und in der Düsenträgerhalterung (9) ausgebildet sind, und dass die Haupthalterung (72) und die Düsenträgerhalterung (9) mit wechselseitig eingreifenden Einrichtungen (24, 25) versehen sind, die miteinander zusammenwirken, um die korrekte Position zu definieren, in der die zusammenwirkenden Löcher (21, 22) zueinander ausgerichtet sind.

6. Funktionskopf nach Anspruch 1, **dadurch gekennzeichnet, dass** zwei Verbindungselemente (16) vorgesehen sind, die einander diametral gegenüberliegen.

7. Funktionskopf nach Anspruch 1, **dadurch gekennzeichnet, dass** das Arretierelement aus einem Schnellarretierelement besteht.

8. Funktionskopf nach Anspruch 7, **dadurch gekennzeichnet, dass** das Arretierelement aus einem Arretiering (26) besteht, der von der Düsenträgerhalterung (9) gehalten ist und um einen Winkel von weniger als 360° gedreht werden kann, um von einer außer Betrieb befindlichen Position in eine Betriebsposition bewegt zu werden, in der er an der Haupthalterung (72) eingreift, um die Düsenträgerhalterung (9) in ihrer Kopplungsposition mit der Haupthalterung (72) axial zu arretieren.

9. Maschine zum Schneiden von Materialien mit Hilfe eines hydro-abrasiven Hochdruckstrahls, umfassend wenigstens einen Wasserstrahl-Funktionskopf der entlang einer oder mehrerer Achsen (X, Y, Z) beweglich ist, **dadurch gekennzeichnet, dass** der Kopf gemäß wenigstens einem der vorhergehenden Ansprüche hergestellt ist.

10. Maschine nach Anspruch 9, **dadurch gekennzeichnet, dass** sie eine elektronische Steuereinheit zum Steuern der Bewegung des Kopfes (7) und ein Magazin (M) umfasst, das einen oder mehrere leere Sitze hat und ein oder mehrere Sitze mit Ersatzteilen

bestückt sind, wobei jedes Ersatzteil ein Düsenträgerelement (9) mit den zugehörigen Elementen umfasst, die einer Abnutzung ausgesetzt sind, und die Steuereinheit dazu programmiert ist, eine automatische Ersetzung des Teils des Kopfes (7) durch folgende Schritte auszuführen:

- Bewegen des Kopfes (7) in die Nähe eines leeren Sitzes des Magazins (M),
- Bringen des Arretierelementes (26) in seine außer Betrieb befindliche Position, um so den Teil des Kopfes in dem leeren Sitz des Magazins anzuordnen,
- Aufnehmen eines Ersatzteils aus einem weiteren Sitz des Magazins durch Ineingriffbringen des jeweiligen Düsenträgerelementes (9) und Bringen des Arretierelementes in seine Betriebsposition, um so die Düsenträgerhalterung (9) des neuen Ersatzteils in der Kopfhaupthalterung (72) zu halten.

Revendications

1. Tête de travail à jet d'eau permettant de couper des matériaux avec un jet hydro-abrasif à haute pression, comportant :

- une partie principale de tête (7A), destinée à être montée sur une machine de travail, et définissant un passage axial (8) pour alimenter un flux d'eau à haute pression,
- un support porte-buses (9) qui est relié de manière amovible à la partie principale de tête (7A),
- une buse de concentration de jet (10) permettant d'émettre un jet hydro-abrasif à haute pression, montée dans ledit support porte-buses (9) et définissant un passage d'éjection (12) qui est agencé en aval dudit passage d'alimentation (8) et est en communication avec celui-ci,
- une buse primaire (13, 13a) portée par ledit support porte-buses (9) en amont de la buse de concentration (10) et ayant un corps pourvu d'un orifice (14, 14a) de diamètre prédéterminé interposé dans la communication entre le passage d'alimentation (8) en flux d'eau et le passage d'éjection (12) à jet hydro-abrasif, et
- au moins un élément de liaison (16) porté par ladite tête (7), à travers lequel un agent abrasif peut être alimenté dans le flux d'eau à haute pression au niveau d'une chambre de mélange (C) définie dans le support porte-buses (9), entre la buse primaire (13, 13a) et la buse de concentration (10),

dans laquelle :

- ledit élément de liaison (16) est porté par ladite

partie principale de tête (7A) et reste donc associé à celle-ci lorsque le support porte-buses (9) susmentionné est retiré de ladite partie principale,

- ladite partie principale de tête (7A) comprend un support principal (72) définissant une cavité cylindrique (20) et ledit support porte-buses (9) comprend un corps adapté pour être reçu de manière coulissante et amovible à l'intérieur de ladite cavité cylindrique (20) dudit support principal (72), et
- ladite tête (7) comprend en outre un élément de verrouillage (26) permettant de verrouiller axialement le support porte-buses (9) dans sa position d'accouplement à l'intérieur dudit support principal (72), ledit élément de verrouillage pouvant être commuté entre un état de fonctionnement et un état de repos,

ladite tête (7) étant **caractérisée en ce que** ledit élément de verrouillage (26) est un élément séparé par rapport au support porte-buses (9).

2. Tête de travail selon la revendication 1, **caractérisée en ce que** ladite buse primaire (13, 13a) est sous la forme d'un anneau et est portée par ledit support porte-buses (9) de manière à rester associée à ce dernier lorsque le support porte-buses (9) est retiré du support principal (72) de la tête (7).
3. Tête de travail selon la revendication 1, **caractérisée en ce que** ladite buse primaire (13, 13a) est formée d'un seul tenant avec ledit support porte-buses (9).
4. Tête de travail selon la revendication 1, **caractérisée en ce que** le corps du support porte-buses (9) a une extrémité conique de centrage (9A) facilitant l'insertion du support porte-buses (9) à l'intérieur de ladite cavité cylindrique (20) du support principal (72).
5. Tête de travail selon la revendication 1, **caractérisée en ce que** ledit élément de liaison (16) est porté par ledit support tubulaire principal (72) et est en communication avec un passage auxiliaire défini par deux trous (21, 22) alignés et substantiellement radiaux qui sont respectivement formés dans ledit support principal (72) et dans ledit support porte-buses (9), et **en ce que** ledit support principal (72) et ledit support porte-buses (9) sont dotés de moyens (24, 25) s'engageant mutuellement qui coopèrent les uns avec les autres pour définir la position correcte dans laquelle lesdits trous (21, 22) coopérants sont alignés l'un avec l'autre.
6. Tête de travail selon la revendication 1, **caractérisée en ce que** deux éléments de liaison (16) sont prévus de manière diamétralement opposée l'un par rapport à l'autre.

7. Tête de travail selon la revendication 1, **caractérisée en ce que** ledit élément de verrouillage est constitué par un élément de verrouillage rapide.
8. Tête de travail selon la revendication 7, **caractérisée en ce que** ledit élément de verrouillage est constitué par un anneau de verrouillage (26) porté par le support porte-buses (9) et pouvant tourner d'un angle inférieur à 360° afin d'être déplacé d'une position de repos à une position de fonctionnement dans laquelle il s'engage sur le support principal (72) pour verrouiller axialement le support porte-buses (9) dans sa position d'accouplement à l'intérieur du support principal (72). 5 10 15
9. Machine permettant de couper des matériaux au moyen d'un jet hydro-abrasif à haute pression, comprenant au moins une tête de travail à jet d'eau pouvant se déplacer le long d'un ou de plusieurs axes (X, Y, Z), **caractérisée en ce que** ladite tête est réalisée conformément à une ou plusieurs des revendications précédentes. 20
10. Machine selon la revendication 9, **caractérisée en ce qu'elle** comprend une unité de commande électronique permettant de commander le mouvement de la tête (7) et un magasin (M) ayant un ou plusieurs sièges vides et un ou plusieurs sièges occupés par des pièces de rechange, chaque pièce de rechange comprenant un élément porte-buses (9) avec les éléments associés qui sont soumis à l'usure, ladite unité de commande étant programmée pour effectuer un remplacement automatique de ladite partie de la tête (7) par les étapes suivantes qui consistent : 25 30 35
- à déplacer la tête (7) à proximité d'un siège vide dudit magasin (M),
 - à amener ledit élément de verrouillage (26) à sa position de repos, de manière à déposer ladite partie de la tête dans ledit siège vide du magasin, 40
 - à prendre une pièce de rechange d'un autre siège du magasin en engageant le support porte-buses (9) respectif et en amenant ledit élément de verrouillage à sa position de fonctionnement, de manière à retenir le support porte-buses (9) de la nouvelle pièce de rechange dans le support principal de tête (72). 45 50 55

FIG. 1

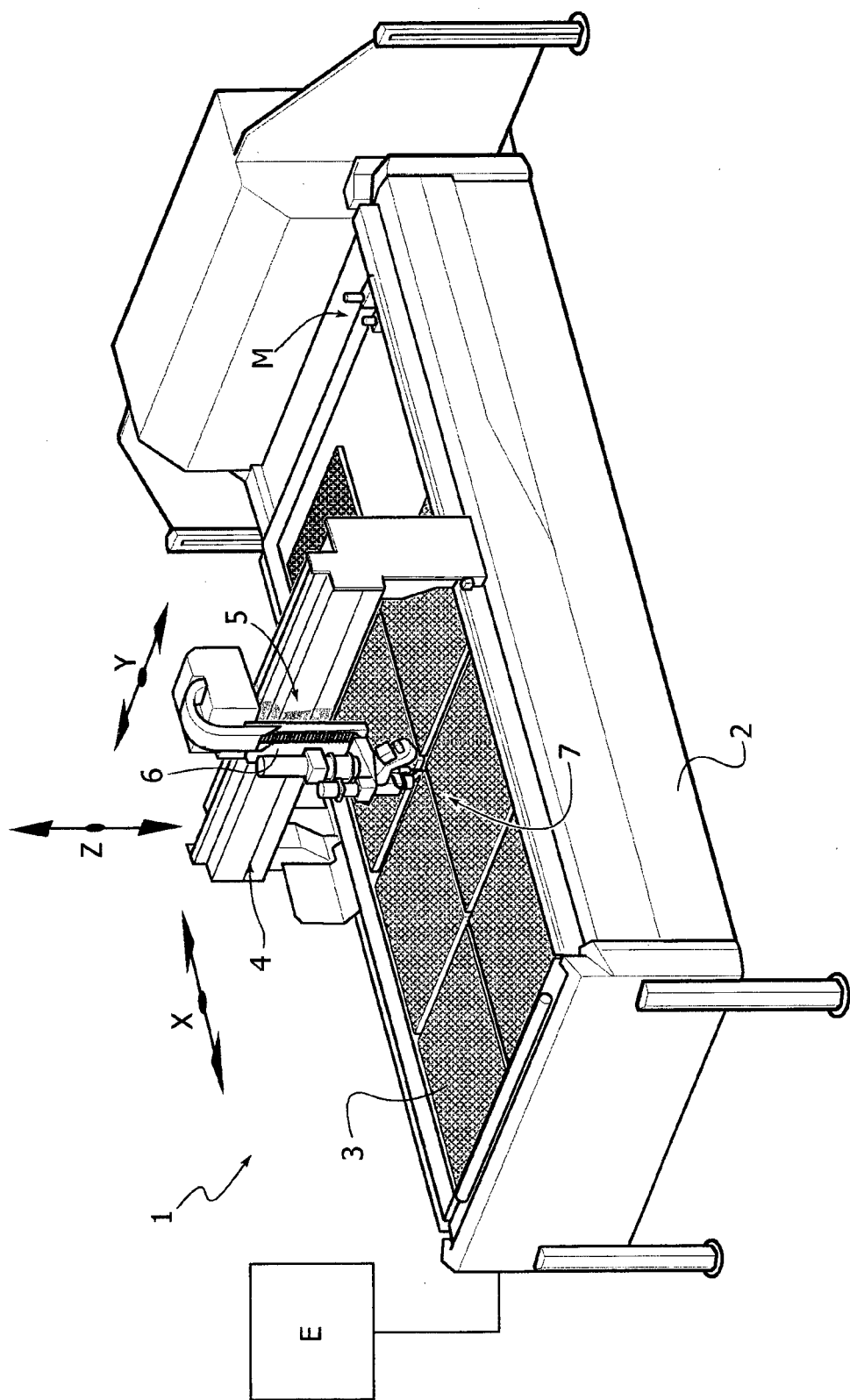


FIG. 2

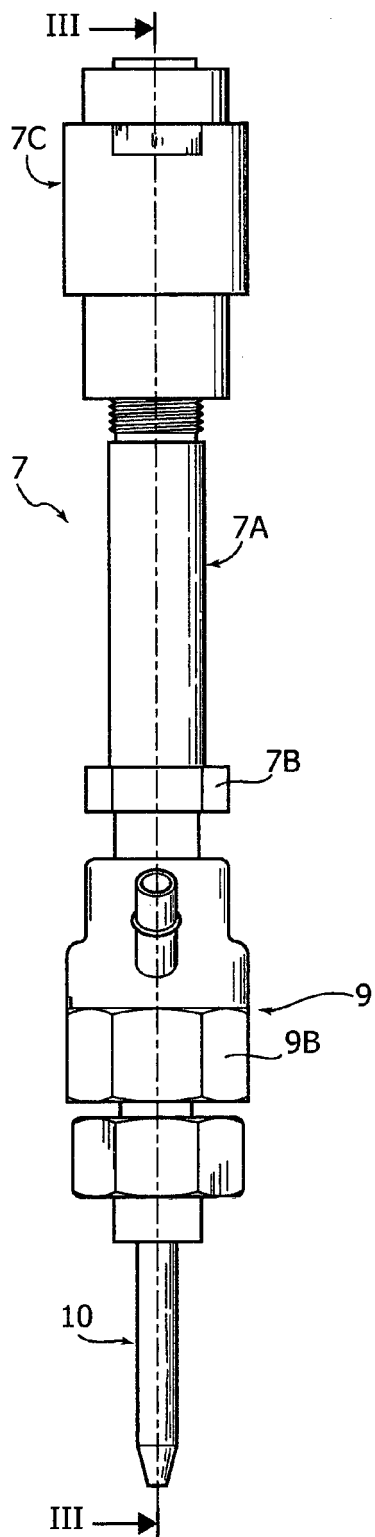


FIG. 3

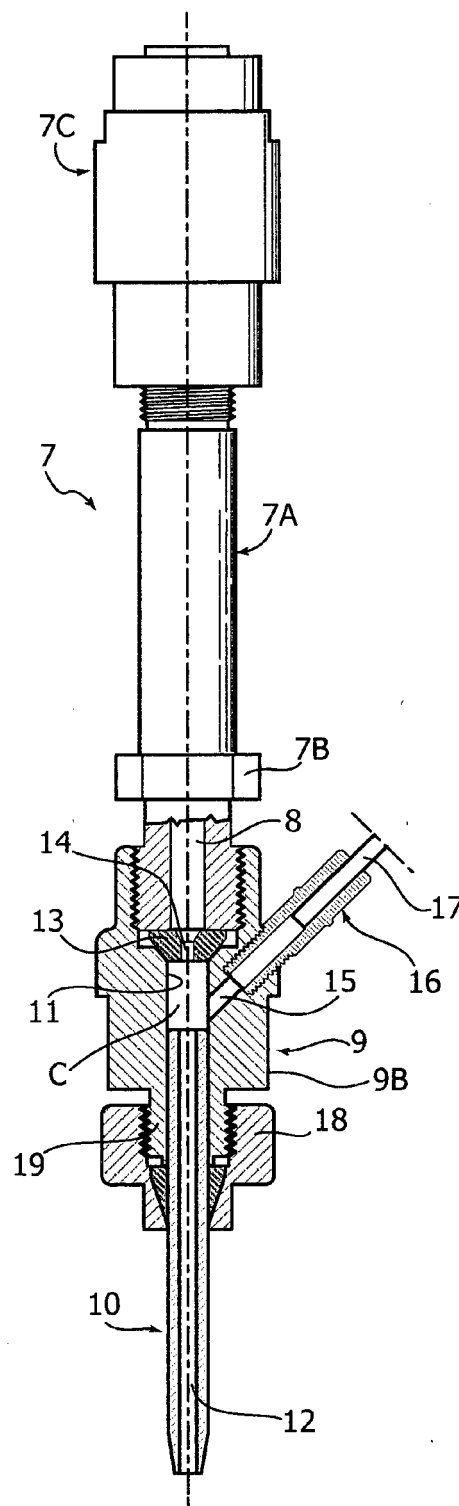


FIG. 4

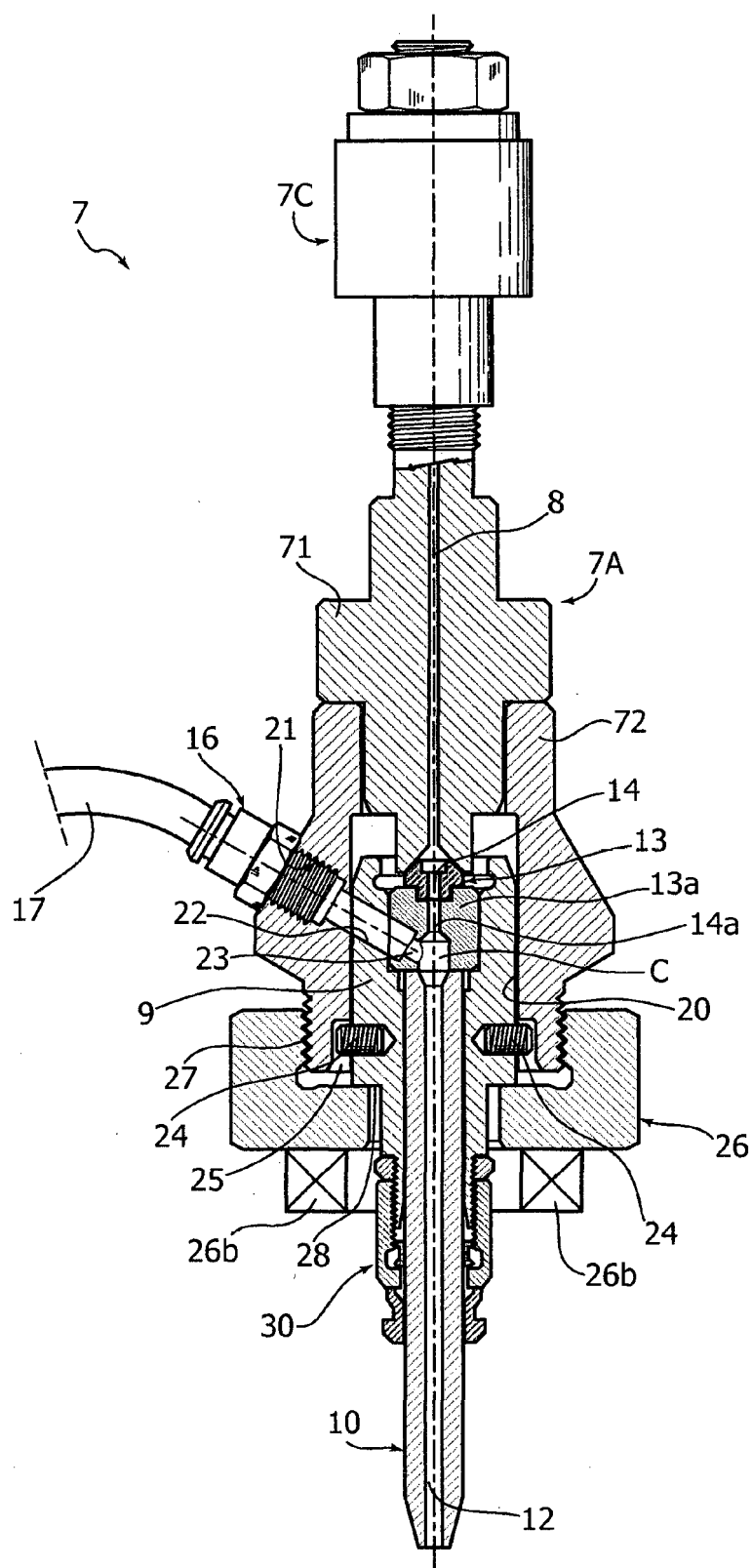
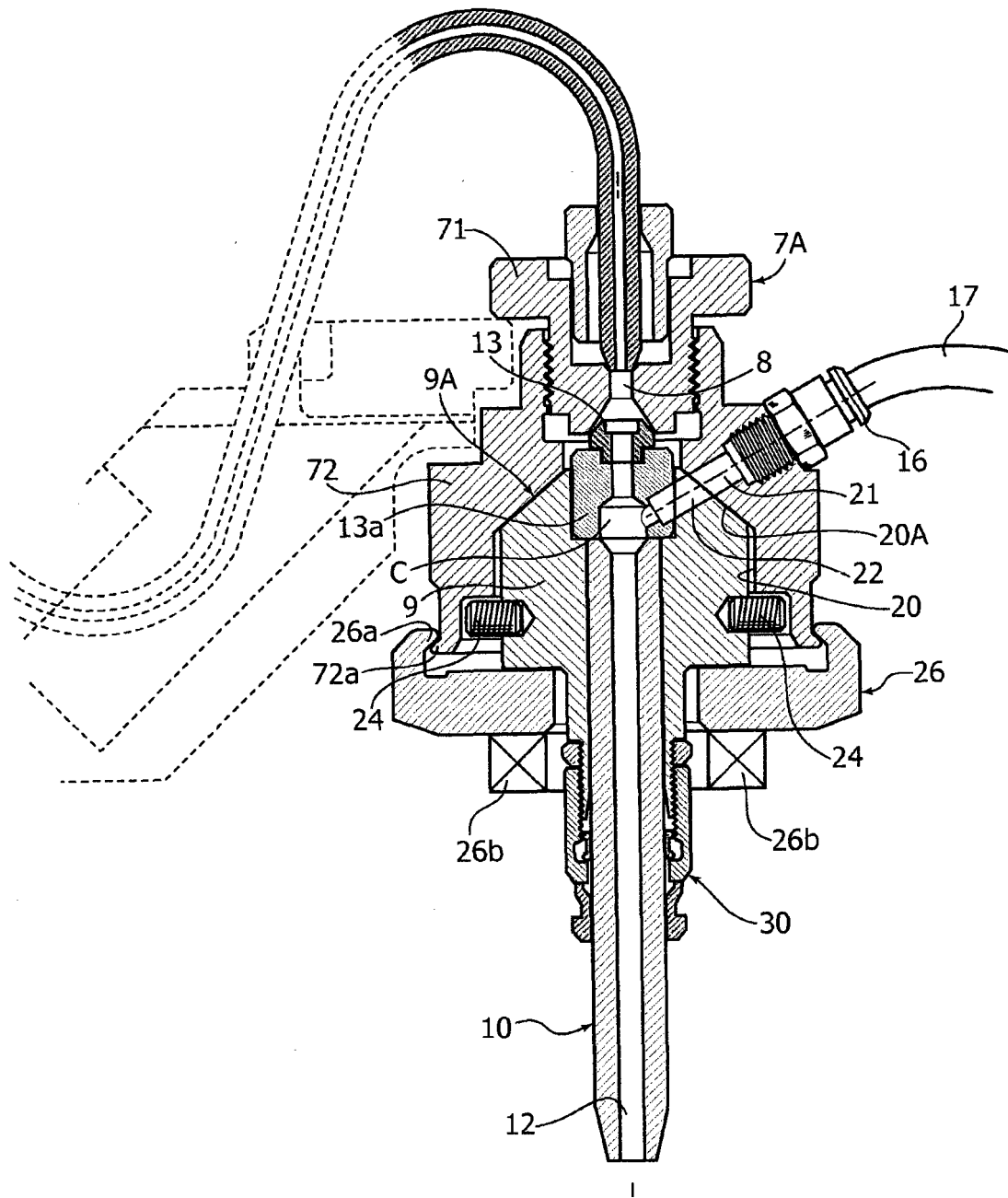


FIG. 5



REFERENCES CITED IN THE DESCRIPTION

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